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UNDERGRADUATE PILOT TRAINING: INSTRUCTOR PILOT BEHAVIOR AND STUDENT STRESS AND PERFORMANCE

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Research has shown flying training to be a very stressful experience. Stress appears to be greater in less capable students. One of the most salient stress producing agents in pilot training is the instructor pilot. Studies have shown that instructor pilot behavior can be quantified and its stress-producing quality measured. The stress response of students can be assessed via measurement of cathecholamines excreted into the urine. The present research examined the interaction between instructor and student during selected rides of the instrument phase of T-37 training. Two issues were addressed: Quantification of Instructor Pilot behavior and its relation to student stress and performance. Six instructor pilots and 12 students served as subjects. Instrument training sorties in the

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T-50 instrument flight simulator were tape recorded and analyzed to determine the frequency of 12 categories of instructor pilot behavior. Student stress levels were determined through analysis of urine samples collected immediately following each sortie. Four instructors were found to use a generally positive teaching style and two a negative style. Stress was greater in students of negative instructors. Negative correlations were obtained between student performance and several instructor pilot behaviors.

PREFACE

This research was conducted by the Human Performance Laboratory; Department of Health and Physical Education; Arizona State University under provisions of Contract F33615-78-C-0053 with the Air Force Human Resources Laboratory.

Special thanks are extended to the 96th Flying Training Squadron at Williams AFB. Without the cooperation, commitment, and interest of the Flight Commanders, Flight Schedulers, and Instructor Pilots the quality of the study would have been compromised.

Capt Daniel C. Boone, AMD/VNE, reviewed this technical report and offered numerous suggestions regarding future research. The time and effort he expended on this review are appreciated.

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UNDERGRADUATE PILOT TRAINING: INSTRUCTOR PILOT BEHAVIOR AND STUDENT STRESS AND PERFORMANCE

1. Introduction

Studies on Student pilots have led to the conclusion that flight training is quite stressful (Mefford, Hale, Shannon, Prigmore, & Ellis, 1971; Melton, Hoffmann, & Delafield, 1969; Melton, McKenzie, Kelln, Hoffmann, and Saldivar, 1975; Melton & Wicks, 1967). Stress appears to be greater in inferior students (Krahenbuhl, Marett, & King, 1977a, 1977b) than in their superior counterparts and has been implicated as one of the most prevalent causes of self-initiated elimination from undergraduate pilot training (King, personal communication, 1974).

Instructor pilots (IPs) and their particular approaches to teaching have been identified as significant stress-producing agents in pilot training programs (Melton & Wicks, 1967). Studies of instructional techniques and behaviors have been conducted in a variety of educational settings. The results of these investigations indicate that instructor behavior can be quantified and that instructor behavior has an effect on both the learning climate and the efficiency with which learning occurs (Amidon & Flanders, 1967; Darst, 1976; Tharp & Gallimore, 1976).

Neuroendocrine responses, indirectly assessed through urinalysis, have frequently been used to reflect the human stress that is incident to flight training. The excretions of epinephrine and norepinephrine are treated as dependent variables that reflect the influence of the flight training environment on the student pilot. As a respondent of emotional stress, catecholamine excretion is considered to be reliable and nonspecific (Smith, 1973). Excretion levels are believed to reflect accurately the relative intensity of the stress, as perceived by the subject, rather than the absolute intensity.

The physical demands of a given undergraduate pilot training (UPT) lesson unit are similar for all students. Stress research has shown, however, that individuals vary considerably in their emotional response to the same stressor (Pitts, 1969). This marked variation has also been noted for student pilots (Melton et al., 1975). The

reaction is believed to be influenced by the subject's perception of the probability, proximity, and degree of unpleasantness of the event, which is viewed as undesirable (Curran & Wherry, 1965).

In a learning environment, high levels of arousal bias the student's search process toward readily accessible stored information (Eysenck, 1976). Since these dominant responses are seldom appropriate in the new setting, this behavioral rigidity slows learning and increases the number of hours required to attain competence.

II. Rationale

Flight training selection is a rigorous process; nevertheless, some students routinely fail to successfully complete flight training programs. Previous work has shown that stress may influence success in flight training. The IP and the approach of that IP to teaching have been identified as strong stress-producing elements, and variations in instructional behaviors have been shown to have an effect on learning. Thus, the simultaneous measurement of instructor behavior, student stress, and student learning offer a greater understanding of the flight training process.

III. Objectives

There were two objectives in this investigation. Of primary concern was the collection of descriptive data on both the behavioral characteristics of instructor pilots and the stress responses of their students. The second objective was to examine the differences in student performance and student stress which accompany different instructional approaches.

IV. Methodology

Six instructor pilots and 12 undergraduate pilot training students served as subjects; each instructor worked with one pair of students; these assignments were in effect prior to the commencement of the study.

Informed consent was obtained from all participants during a meeting in which a detailed explanation of the entire investigation was given.

The initial instrument phase of UPT training was selected for study. Four instructional units (B1501, B1502, B1503, and B1701) performed in the T-50 instrument flight simulator were monitored (Air Training Command, 1979). All lessons were close to the projected length of approximately 1.3 hours.

An audio cassette was used to record all the sessions selected for study. Behavior rates were determined from tape analysis using the event recording technique (Siedentop, 1976). The specific behaviors identified for this investigation were selected during careful preliminary study and are as follows:

1. Commands are orders or directions that result in immediate student responses. These are not meant as an instructional cue or prime but tell the student to do something. For example, "make a right turn."

2. Instructional cues give facts, opinions, ideas, clarifications, primes, prompts, techniques relative to the task at hand and answer a question with information. For example, "make sure your pitch and power are appropriate for landing."

3. Questions ask for information and force students to think or respond. For example, "how fast should we be going?"

4. Acceptance affirms that the student's response is correct. For example, "O.K., that's correct, you're right."

5. Praise-General is a positive statement relative to a student response that does not carry any specific information. For example, "very good, I liked that, good work."

6. Praise-Specific is a positive statement that carries specific information about a student response. For example, "very

good, you kept your air speed right at 190 or good wing position throughout the turn."

7. <u>Correction</u> is a verbal reaction pointing out an incorrect student response without using criticism, ridicule, sarcasm, or emotion. For example, "get your trim, keep your nose up, you're too high."

8. <u>Scold-General</u> is rejecting a student's response or using criticism, ridicule, and sarcasm without any specific information on the response. For example, "that was terrible."

9. <u>Scold-Specific</u> is the same as Category 8, except that it contains specific information with reinstruction information for the student. For example, "that was terrible, you let the nose drop too much."

10. <u>Modeling-Positive</u> is showing students how to do something the proper or correct way. For example, the instructor takes over the plane and performs the appropriate landing.

11. <u>Modeling-Negative</u> is showing students what they did wrong or how they did it wrong. For example, the instructor takes over the plane and performs a turn too slow or fast.

12. <u>Other</u> consists of behaviors that do not fit in the above categories.

Tapes were analyzed by four independent observers who tabulated the number of each type of behavior used during each lesson. Reliability checks indicated an agreement rate between the independent observers of 87 percent; this is well within the acceptable range (Siedentop, 1976). Behavior rates were calculated by dividing the number of behaviors emitted during a lesson by the length of the lesson.

Student stress was estimated from timed urine

samples used to quantify catecholamine excretion. Baseline excretion data were collected on two nonflying days. These inactivity days were selected to avoid academic and physical training requirements, thus minimizing stress.

Immediately prior to each training sortie, the subjects emptied their bladders and drank at least 250 ml of water, thereby reducing possible errors due to inadequate amounts of urine from voluntary bladder emptying. A post-lesson sample was collected upon exit from the T-50 simulator. The exact length of time and total volume of the sample were noted.

A 100 ml aliquot of each urine sample was stabilized at pH 4.0 and frozen. Free epinephrine and norepinephrine were determined using a resin column isolation technique (Bio-Rad Laboratories, 1975). Standard solutions of epinephrine and norepinephrine and aliquots of standard pools were included as a check of validity. Duplicate determinations were run as a check of reliability.

The scores recorded on the students' Basic UPT grade reports were used as an indication of performance. Letter grades were converted to numeric data. A mean performance score for each sortie was determined by dividing the accumulated total of all items by the number of items attempted.

V. Results and Discussion

Catecholamine excretion is believed to reflect the general stress response as experienced by the individual (Euler, 1964). Figure 1 depicts the mean catecholamine excretion rates for UPT students during the T-50 Instrument Flight Simulator lesson units selected for study. Significant mean differences in excretion rates occurred across the five trials (Table 1). Duncan's Multiple Range Test (Edwards, 1968) was employed to explore the contrasts responsible for significant trial effects. The results of this test indicated that all the simulator instruction units resulted in a statistically significant ($p < 0.05$) increase in catecholamine excretion over basal rates. No other differences were noted.

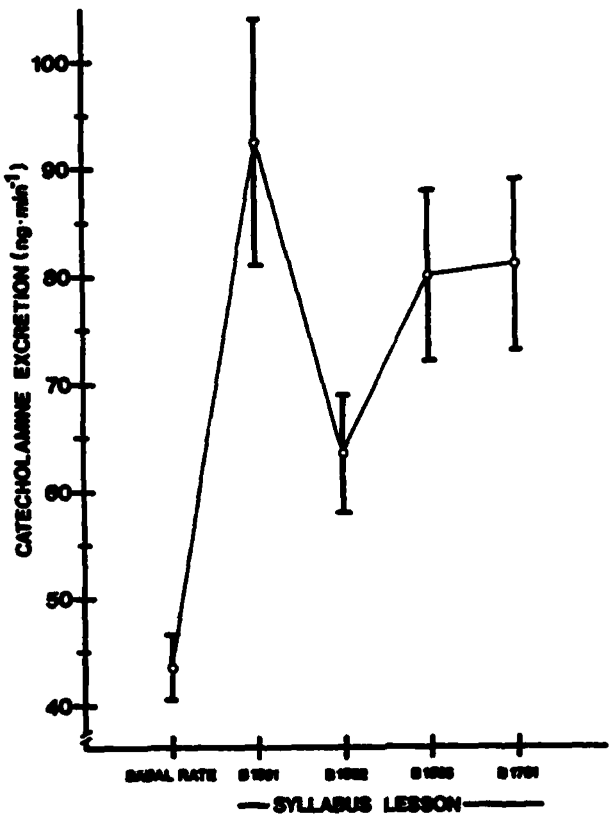

Figure 1. Catecholamine excretion of undergraduate pilot training students during basal and T-50 instrument flight simulator lesson units (mean ± sem).

TABLE 1. Summary of ANOVA for Catecholamine Excretion

Source	Mean Square	df	F	P
Trials	4318.1055	4	5.258	0.0018
Error	821.2951	44		
Total	1175.9061	59		

The excretion rates from the current investigation are slightly lower than stressful units flown by students in the T-37 aircraft (Krahenbuhl et al., 1977a, 1977b), but are very similar to those reported for power-on-stall and spin recovery units flown by students in the Advanced Simulator for Pilot Training (ASPT) (Krahenbuhl, Marett, & Reid, 1978, 1979). The current values are slightly higher than those observed in instructor pilots performing power-on-stalls and spin recoveries in the ASPT (Krahenbuhl et al., 1978, 1979).

The instructor behavior data were collapsed across trials in order to calculate mean rates for each instructor. The behavioral techniques used by the instructors during the Instrument Flight Training Lesson units selected for study (B1501, B1502, B1503, B1701) are illustrated in Figure 2. The most commonly used behavior was that of providing instructional cues. Direct commands for action were next most common, followed by corrections, questions, and statements indicating acceptance. Other types of behavior were used by this group of instructors, but at a low rate.

Instructors were then categorized according to the nature of their instructional approach. Instructor pilots who relied on acceptance and praise were placed in one group (POSITIVE; n=4). The instructor pilots who relied on harsher tones, criticism, and scolding were placed in a second group (NEGATIVE; n=2). Each instructor taught eight lessons that were monitored (two students each x four sorties); thus there were 16 lessons monitored for the NEGATIVE group and 32 lessons monitored for the POSITIVE group. Figure 3 depicts the differences in the behaviors used in lessons taught by the POSITIVE IPs and those taught by the NEGATIVE IPs. The behavior rates for the two groups were compared using the Mann-Whitney _U_ Test (Siegel, 1956). This statistical test was selected because the assumptions required for a parametric test

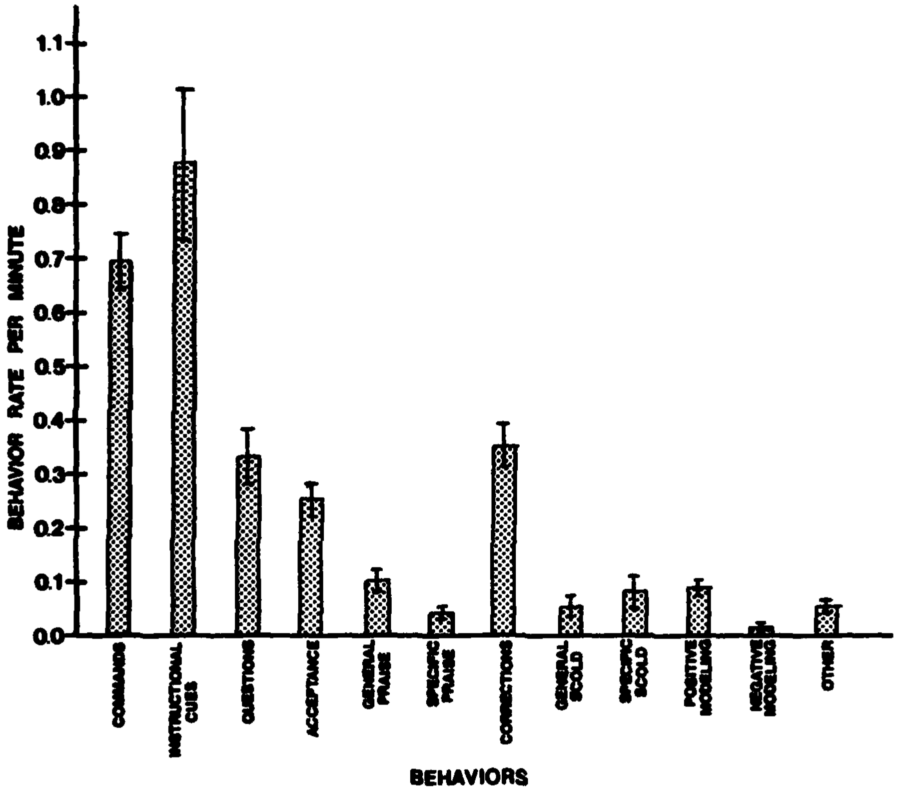

Figure 2. Emission rate of behaviors used by instructor pilots while teaching instrument flight training lesson units in the T-50 simulator (mean ± sem).

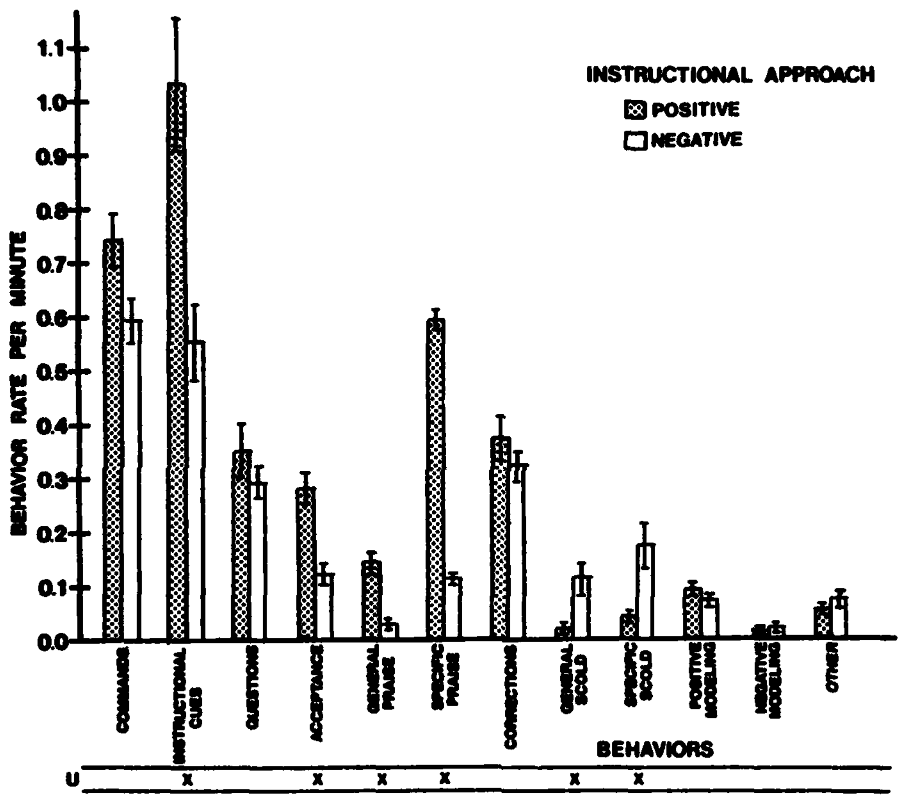

Figure 3. Emission rate of behaviors used by instructor pilots using positive and negative instructional approaches while teaching instrument flight training lesson units in the T-50 simulator (Mean ± sem). Bottom: Mann-Whitney U statistic indicating significance at the 95 percent level of confidence.

could not be met with such small groups. By definition, the POSITIVE group made greater use of acceptance, general praise, and specific praise while the NEGATIVE group made greater use of both general and specific scolding. These significant differences were expected. The total behavior rates for the two groups (POSITIVE, 3.18 per min.; NEGATIVE, 2.35 per min.) were not significantly different according to the Mann-Whitney U Test. The POSITIVE group, however, exhibited a greater use of instructional cues (Figure 3), demonstrated a higher praise/scold ratio (POSITIVE, 6.16:1; NEGATIVE, 0.38:1), and used what are hypothesized to be more effective instructional behaviors (instructional cues, questions, corrections, and modeling) at a significantly higher rate (POSITIVE, 1.85 per min.; NEGATIVE, 1.25 per min.). Therefore, it should be apparent that the character of the lessons taught by the POSITIVE instructors differed markedly from those taught by instructors in the NEGATIVE group, even though the lessons covered identical material.

The catecholamine excretion rates of the students during lessons taught by the POSITIVE and NEGATIVE instructors are compared in Table 2. The students taught by POSITIVE instructors exhibited significantly lower catecholamine excretion rates; therefore it appears that lessons taught by the POSITIVE group were less stressful. There were no statistically significant differences in norepinephrine excretion; however, the rate of epinephrine excretion of students was also lower in the lessons taught by the POSITIVE group. This latter finding suggests that emotional arousal was higher in the students taught by instructors in the NEGATIVE group.

A final topic addressed in the current investigation was the relationship between student performance and the behavior rates exhibited by instructors on the syllabus units. These relationships are displayed in Table 3. Twelve tests for statistical significance were made; therefore, in an attempt to control Type I error, only correlations with probabilities less than 0.005 were considered to be significant. There were statistically significant negative relationships between performance and questions, corrections, general and specific scolds, and positive modeling.

Although cause-effect cannot be implied from correlation, the negative relationships between performance and questions, corrections, positive modeling, and

TABLE 2. Comparison of Student Stress Responses from Lesson Units Taught by Positive and Negative Instructors

Variable	Approach	$\bar{X}$	SD	Significance[a]
EPINEPHRINE				
	POSITIVE	27.6	10.9	<0.05
	NEGATIVE	41.1	9.8	
NOREPINEPHRINE				
	POSITIVE	42.7	11.6	NS
	NEGATIVE	55.6	6.1	
CATECHOLAMINE				
	POSITIVE	70.4	18.9	<0.01
	NEGATIVE	96.7	12.0	

[a] Mann-Whitney *U*

TABLE 3. Relationship between Performance on Syllabus Units and Behavior Rates Used in Those Lessons (n=48)

Behavior	Relationship[a] with Performance	Significance[b]
Commands	-0.038	NS
Instructional Cues	-0.091	NS
Questions	-0.406	0.004
Acceptance	0.086	NS
General Praise	-0.361	NS
Specific Praise	-0.266	NS
Corrections	-0.515	0.0001
General Scold	-0.442	0.001
Specific Scold	-0.461	0.001
Positive Modeling	-0.425	0.002
Negative Modeling	0.299	NS
Other	-0.124	NS

[a] Pearson Product Moment.

[b] Two-tailed Significance.

scolding are not surprising, for it might be expected that these behaviors would be more frequently used with poorly performing students. The relationship between the total behavior rate and performance was r = -0.394 ($p < 0.01$). This negative relationship also suggests that the instructor pilots tended to emit more total behaviors with the poorer students, while the better students were allowed to operate with fewer instructor interruptions.

VI. Conclusions

The present study represented an attempt to describe, via event recording and catecholamine excretion, the instructor teaching approaches and the student stress in the instrument training phase of UPT. Data were collected during daily activities (BASAL) and during selected sorties performed in the T-50 Instrument Flight Simulator. The following conclusions were drawn:

1. The sorties performed in the T-50 Instrument Flight Simulator selected for study resulted in a pronounced stress response in the subjects.

2. Although the lesson content is very structured, the IPs vary greatly in the behaviors they use to instruct the student.

3. Student stress responses are greater in lessons taught by IPs using low rates of acceptance and praise behaviors and high rates of scold behaviors. Stress responses of students taught by instructors using the opposite approach experience significantly lower stress.

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